OUTPUT VOLATILITY IN MACEDONIA: A ROLE FOR THE EXCHANGE RATE?

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Abstract: The study aims to empirically explore the relationship between exchange-rate rigidity and output volatility for Macedonia, building on the flaws of the existing, though scarce literature on the topic. Specifically, it carefully constructs the output volatility regression; considers the measure of output volatility; and accounts for the endogeneity bias doubted to be present in the respective literature. Moreover, it utilizes a Hodrick-Prescott definition of volatility, to avoid persistent series which are obtained by using rolling standard deviations. The empirical investigation covers the period 1998:Q1 - 2009:Q2 and uses a GMM estimator. We find that, in general, a TOT shock opts to increase output volatility, but under a more flexible regime, it starts to affect the output fluctuations negatively, implying a role of a buffer. Quite the contrary, when nominal shocks (monetary and/or fiscal) hit the economy, a more rigid alternative of the exchange rate is preferable.

JEL Classification: E58, F41, F43

Keywords: exchange-rate regime, output volatility

1. Introduction

There are firm theoretical grounds and empirical evidence that exchange-rate peg introduces inflation of the anchor country into the domestic economy (Garofalo, 2005; Xu, 2004; Levy-Yeyati and Sturzenegger, 2001; Edwards, 2000; Mills and Wood, 1993 and others). However, peg's effect on growth remains inconclusive even at empirical level (De Grauwe and Schnabl, 2004; Domac et al. 2004b; Husain et al. 2004; Bailliu et al. 2003; Edwards and Levy-Yeyati, 2003; Eichengreen and Leblang, 2003; Levy-Yeyati and Sturzenegger, 2002; Moreno, 2001 and 2000). Some of the studies argue that the exchange rate, as a nominal variable, similarly to inflation might not be related with long-run growth, but instead with its short-run departure from the long-run trend, i.e. with the output volatility. In addition, "[t]he linkages among the international financial system, a country's exchange-rate regime and its domestic real and financial sectors are quite complex and dynamic, challenging our simple models and conventional understanding." (Piragic and Jameson, 2005, p.1465). The assertion stems from the reality that the global capital mobility increased in the last decade, the conclusion being particularly relevant for the emerging economies. This revives the older debate of fixed versus flexible exchange rates and, in particular, the possibly detrimental effects of exchange-rate peg on the short-run real activity under strengthened exposure of the economy to real shocks. This study aims to empirically explore the relationship between exchange-rate volatility and output volatility for the case of Macedonia, building on the flaws of the existing, though scarce literature on the topic.

The paper is organized as follows. The next section establishes the theoretical grounds of the relationship between exchange-rate rigidity and output volatility and reviews the empirical evidence. Section 3 briefly describes the data. Section 4 portrays the model, reports the findings and offers some discussion. The last section concludes the study.

2. Exchange-rate rigidity and output volatility– theoretical overview

The core assertion of the Natural Rate Theory is that inflation cannot affect output in the long run. Once nominal wages are set, based on anticipated inflation rate, the labor supply meets labor demand and the market is cleaned. If the central bank eases monetary policy and inflation increases, the real wage decreases because the nominal one is fixed. Firms have incentives to increase labor demand, hence increasing employment and output. In other words, overly expansionary monetary policy which aims at higher employment might shift output from its potential level and create a short-run effect of a booming economy (see, for instance, Mankiw, 2006). At this point, the incentives of policymakers and consumers differ: the former try to surprise the latter after they have announced zero inflation. However, this behavior of the central bank undermines its credibility: workers become rational instead of adaptive in their expectations, as Kydland and Prescott (1977) explained, and anticipate this "inflation bias". The game of the central bank is quickly understood by economic agents; they do not believe the central bank when announcing zero inflation targets and increase their nominal wage demands. On balance, in the long-run, output gets back to its trend level but prices have increased. Levy-Yeyati and Sturzenegger (2001) generalize this conclusion to all nominal variables including the exchange rate, stating that they are believed to be uncorrelated with the longer-term real performance of the economy. In Petreski (2009a) and (2009b), we have argued that the relationship between them, even if it exists, remains unclear. This view implicitly articulates that the exchange rate might not be crucial for affecting output growth, but rather for the departure of output from its long-term level or output volatility. However, the literature is not in agreement on this issue. Writers have been unclear; for instance, Moreno (2001) explains how the peg, which imposes monetary and fiscal restraint, causes increased output volatility under a shock, but then he says that pegging helps policymakers' ability to respond to shocks and reduce output volatility, without explaining how and why. What is the true relationship, hence, remains an empirical question.

A general observation in the literature is that, however, the origin of the shock matters. If a monetary shock hits the economy (shifts the LM curve), then a peg will reduce output volatility. A monetary shock might mean that the preference between money and bonds changes - the volatile interest rate on bonds increases money demand and shifts the LM curve out. This volatility will spill over other interest rates in the financial system. Consumers and firms will be deterred from borrowing/investing (binding credit constraints) when the rate is unfavorable and vice versa. But, as interest rates are volatile, the behavior of economic agents (households and firms) will result in volatile output (Chang and Velasco, 2000). The peg provides macroeconomic stability, it anchors inflation expectations and keeps interest rates steady. Hence, shocks over the LM curve might be buffered under a more rigid exchange rate, which, in such circumstances stabilizes output volatility. For instance, in the event of a negative demand shock, the money supply will decrease as the monetary authority sells foreign reserves to prevent the depreciation of the local currency and real output is left unchanged. On the other hand, more flexible regimes require income to rise so that real money demand is increased back to the unchanged level of real money supply. Therefore, if nominal shocks predominate in the economy, this is an argument in favor of more rigid regimes. However, the peg will not insulate the economy from a shock hitting money demand in the anchoring economy. In this case, quite the contrary, the volatility of the foreign interest rates will be directly transmitted onto domestic interest rates.

If the shock is rooted in the real economy (affects the IS curve: like, changes in technology or terms-of-trade shock), a flexible rate will be desirable to smooth output fluctuations and shield the economy from the disturbance. In the case of real domestic shock, currency depreciation will counteract the rise of export prices, whereas in the case of external shock the appreciation will impede the increase of import prices. If this was not the case, then in both cases output would have fallen below its potential. In modern times, increased capital mobility more frequently exposes economies, especially small and open, to external shocks which are usually related to capital flight, conditional on changes in investors' incentives, political factors or global considerations like oil shocks or even terrorism. Therefore, the view that a peg might be beneficial for trade and investment by imposing certainty in the economic environment when nominal shocks predominate, underscores the view that an exchange-rate peg increases output volatility by inflicting price misalignments, soaring interest rates (Calvo, 1997) and misallocation of resources in times of real disturbances. However, Moreno (2001) argues that in a world of sticky wages, a peg will limit the transmission of the real shock (say, shock to productivity) onto output: the adjustment of the real wages and the labor supply is delayed.

Another group of studies (McKenzie, 1999; Pugh et al. 1999), however, argues that floating rates, because of the exchange-rate volatility implied, spillover shocks onto domestic output. The studies of Creedy et al. (1994), Pentecost (1993) and De Grauwe (1996) support the view that exchange rates are unpredictable by demonstrating that nominal exchange-rate movements under a floating regime may be represented as lacking in any periodicity, and hence as chaotic. Therefore, exchange-rate movements cannot be anticipated and, hence, create uncertainty in the economic environment. Moreover, long-run exchange-rate movements are argued to persist for several years (Pugh and Tyrrall, 2001). Rogoff (1999) argues that such variability could be transmitted onto real output and consumption volatility, but in developing countries only. If the financial market is sufficiently developed, hedging instruments could serve the function of absorbers of exogenous shock, an assumption which is yet unrealistic for the developing economies. Also, since long-run exchange-rate variability is less subject to hedging (Cooper, 2000), the exchange-rate regime effect on output volatility remains ambiguous even for the developed economies.

From the discussion, it follows that the way in which an exchange-rate regime affects output volatility is not unclear as much as the effect on growth (see further in Petreski, 2009b), but is likely dependent on the nature of shocks, which should be embedded in any empirical research.

3. Empirical literature review

A detailed critique on the empirical literature on the topic is given in Petreski (2008). Here, for consistency of the argument, we review some of the main points. As said, the literature on the topic is scarce and heterogeneous in any respect. Levy-Yeyati and Sturzenegger (2001) empirically tested the relationship between exchange-rate regime and output volatility on a 183-country sample over the period 1974-2000. The study uses dummies to capture the exchange-rate regimes. It finds that exchange-rate pegs are associated with greater output volatility in developing countries. For advanced economies however, the relationship was found the reverse, which throws doubts over the applied modeling framework. The authors themselves ultimately conclude that the evidence of how exchange-rate regime [might] implicates output volatility is mixed and depends on the level of development of the economy. Here, the potential drawback of using ordinary least squares is corrected in Edwards and Levy-Yeyati (2003), over the same sample and period. The main finding is that under a peg, a 10% deterioration of the terms of trade is associated, on average, with a contemporaneous decline in per-capita growth of 0.8 p.p. Under flexible rate, this figure is 0.43. However, it seems that the standard Engle-Granger procedure for co integration is not applied consistently: the speed of adjustment towards the long-run equilibrium must be negative in order to point a restoration of equilibrium; a positive coefficient would mean that the equilibrium is never restored but rather the misbalance is even amplified. Also, using lagged dependent variable might impose the need for instrument-correction, which is not done and hence renders coefficients biased.

Moreno (2001) focuses on a sample of 98 developing countries over the period 1974-1998 and calculates the average percentage changes of inflation, output growth and volatility under a peg vis-à-vis a floating regime. However, contrary to the initial expectations, output volatility was not found higher under a peg; in essence, the output volatility does not differ between pegging and floating countries in his sample, although it significantly affects both groups.

In Bleaney and Fielding (2002), the standard deviation of the real growth in the period 1980-1989 is regressed, inter alia, on dummies for pegs and pure floats, using de-jure exchange-rate regime classification (see the discussion on this matter in Reinhart and Rogoff, 2004). The study finds that peg is associated with greater output volatility. Similar approach, but different estimation technique is used by Bastourre and Carrera (2003) who include exchange rate dummies which represent de-facto and de-jure regimes separately. The study concentrates on the importance of the measure of output volatility and it uses two measures: inter-annual output volatility (proxied by the volatility of the monthly industrial production) and three-year output volatility, both measured through the standard deviation of the output measure. Conclusions are that peggers exert higher output volatility than intermediate regimes or floaters, irrespective of the way in which the volatility is measured, exchange-rate regime classification used or estimation technique.

A general criticism of the limited number of published studies on the topic is that they use the rolling-standard deviation as a measure of output volatility. However, as it will be argued below, constructed in this manner, the measure adds persistence to the series which, if not accounted for in the estimation process, might lead to spurious results. This is especially the case for studies where the time dimension is considerable, which is the case for merely all the reviewed studies. This concern, at this point, could be justified by comparing the estimates in Bastourre and Carrera (2003) based on intra-annual volatility vis-à-vis those based on rolling standard deviation – those are completely different.

The next table summarizes the above-presented studies:

Table 1. Summary-table of the empirical research of the exchange-rate regime effect on output volatility

Study	Data and sample	ER classification	Model	Technique	Result (Peg and Output volatility)	Problems
Basu and Taylor (1989)	Four sub-samples during 1870-1998	Only general exchange-rate regimes considered	Descriptive analysis	Standard deviation of the included variables	POSITIVE Volatility has been the lowest under the generalized floating (1972-1998)	Unconditional analysis
Moreno (2001)	98 developing economies; 1974-1998	De jure	Descriptive analysis	Average changes in output volatility under alternative regimes	INCONCLUSIVE Output volatility does not differ between pegging and floating economies	Unconditional analysis
Levy-Yeyati and Sturzenegger (2001)	183 countries; 1974-2000	De facto	Volatility of real per capita GDP = f(volatility of inv-to-GDP; volatility of ToT; volatility of government consumption; political instability; initial per capita GDP; population; openness; secondary enrolment; regional dummies; exchange-rate dummies)	OLS	POSITIVE Pegs associated with greater output volatility for developing economies. The opposite for advance economies	Estimation technique?
Edwards and Levy-Yeyati (2003)	183 countries; 1974-2000	De facto	Change of real per capita GDP = f(level of adjustment of the growth rate towards its long-run equilibrium [difference between the term stemming from the growth equation presented in table 1.2. and the lagged actual growth]; terms of trade; civil unrest)	FGLS	POSITIVE 10% deterioration of terms of trade lead to decline in per-capita growth of 0.8 p.p.	Specification econometrically invalid. FGLS used to estimate dynamic regression, but the endogeneity caused by the lagged dependent variable not treated.

Bleaney and Fielding (2002)	80 developing countries; 1980-1989	De jure	Standard deviation of real output growth = f(terms-of-trade volatility; agriculture share; country size; regional dummies; exchange-rate dummies)	OLS	POSITIVE Peg associated with greater output volatility	Estimation technique? ERR classification
Bastourre and Carrera (2003)	45 countries for the regression including the industrial production; 153 countries for the regression including the output as dependent variables; 1974-2000	De facto and de jure	Standard deviation of real output growth = f(per capita GDP, the same variables squared, GDP growth, trade openness, inflation volatility, terms-of-trade volatility, investment volatility, an institutional index, exchange-rate dummies)	Fixed and random effects; dynamic GMM	POSITIVE The more rigid the exchange-rate regime, the higher the output volatility - de-facto peg increases output volatility by about 0.005 p.p. (intra-annual volatility) - de-facto peg increases output volatility by about 0.9 p.p. (rolling-standard deviation volatility) - similar results for the de-jure classification	Not giving preference among the three estimators

3. Data

We use quarterly data over the period 1998:1-2009:2. All included variables are from the National Bank of the Republic of Macedonia and the State Statistical Office. We use Chinn and Ito's (2007) measure of financial openness, because besides using capital inflows and outflows, it also aims at measuring the extensity of capital controls imposed. For the civil unrest, we use the series for the civil liberties from Freedom House, which, as a source, might be contested, but no alternative is at present achievable.

4. Model, methodology and results

The construction of the output volatility framework where the role of exchange rate rigidity will be analyzed should follow an eclectic approach. Firstly, output volatility happens because of shocks hitting the economy: changes in money demand, fiscal stance or changes in the terms of trade as a result of external factors or even a civil unrest in the country would impinge on the real economy. "Employment and output fluctuations inevitably relate to shocks and to the manner in which the economy copes with those shocks" (Easterly et al., 2000, p.8). However, we argue here that different regimes differently channel various shocks on to the real economy. Following the works of Mundell (1968) and Poole (1970), many economists still believe that the relative merits of exchange-rate regimes depend on the nature of shocks that hit the economy. However, while including shock variables is common in the literature (see Petreski, 2009c), the differentiation between real and nominal shocks is neglected. Hence, a well-specified output-volatility regression should make this differentiation.

The rest of the output volatility regression varies in the literature. Easterly et al. (2000) suggest including trade openness, an indicator of financial deepness, price volatility and an indicator of political instability in the output-volatility regression. Mobarack (2001) suggests taking an even broader list of variables, among which are those in a standard growth regression, plus, Gini coefficient, tax revenues, real-exchange-rate volatility, credit to the private sector and war participation. All those suggested variables could be thought of as representing responsiveness to shocks, i.e. buffers, which is again in line with the preceding discussion. Hence, we follow the suggestion of Kose et al. (2005) and Easterly et al. (2000) and we add GDP growth and a bank assets-to-GDP ratio, as these may act as buffers when a shock hits the economy.

Focusing on the exchange-rate regimes literature, one group of academics (Levy-Yeyati and Sturzenegger, 2001; Bastourre and Carrera, 2003) uses volatilities of the same explanatory variables as in a standard growth regression; Bleaney and Fielding (2002) use some variables to capture the country size and agriculture share, since these are important buffers when a shock hits the economy; Edwards and Levy-Yeyati (2003) estimate the growth vector and use its residual in the output-volatility regression to measure the speed of adjustment towards the long-run equilibrium, along with some variables representing shocks. However, they measure the output volatility through differencing the growth series, as in a standard ARDL model, which might be contested. They find a positive sign in front of the lagged residual, which is at odds with conventional wisdom. That is, their results suggest that there is not restoration towards the equilibrium when a shock hits; instead the shock is further amplified. Moreover, output volatility by definition is a kind of residual (from equilibrium growth), so that regressing one residual against another seems at odds with the mainstream econometric techniques and economic reasoning.

We further include a variable for trade and financial openness, to reflect the extent of integration of the economy into global trade and capital markets. Easterly and Kraay (1999) argue that the level of financial development may matter little if firms in the country have easy access to credit abroad. Hence, a high degree of international trade and financial integration could also play a buffer role and smooth output fluctuations. However, while high degrees of openness of capital account could serve to smooth the adjustment of a country to a shock, it may also expose it to another adverse source of dynamic reaction and, in essence, may measure economy's vulnerability to an external shock. Investors, observing the weakening condition of firms and financial institutions within the country in response to a shock, may decide to pull their (short term) money out of the country and put it elsewhere, thus further weakening both firms and financial institutions (e.g. by further weakening the currency) and possibly inducing a crisis. A negative shock to capital account will have adverse effects on the terms at which firms can get access to funds and may be exacerbated by the presence of credit rationing. The increased uncertainty about different firms' balance sheets, caused by the economic disturbance, may lead to a greater prevalence of credit rationing and to further contractions in demand, as firms attempt to increase their liquidity.

Inflation and wage growth should be included in the regression to account for the traditional explanation of output fluctuations by downward nominal rigidities (Newbery and Stiglitz, 1982). Namely, rigid real wages provided an easy explanation of unemployment — a decrease in the demand for labor immediately turns into unemployment (lower output), because real wages are rigid and fail to equilibrate the market. The reduction in the demand for labor could be explained by the falling demand for goods, in itself explained by rigidities in intertemporal prices.

Finally, as Macedonia has used only one exchange rate regime over the observed period, a de facto fixed regime, we cannot use dummy variables. Instead, we calculate the volatility of the nominal effective exchange rate to represent the rigidity of the exchange rate. The regression is as follows:

$$OV_t = \alpha_0 + \beta_j Z_{1,t} + \gamma_j Z_{2,t} + \delta_j Z_{3,t} + \eta_j Z_{4,t} + \varepsilon_t \tag{1}$$

The coefficients are specified according to the groups of variables, as follows:

- ✓ OV_t is the measure of output volatility, defined in two ways: as a centered rolling standard deviation or through an HP filter;
- ✓ βs for the variables representing shocks, $Z_1 = (\Delta TOT, \Delta MS, \Delta GC, CIVIL)$. Note that shocks are all measured as volatilities, so that Δ refers to volatility of changes and not changes themselves. The three measures are defined as a centered rolling standard deviation or through HP-filter;
- ✓ γs for the variables representing shock buffers or measuring the economy's vulnerability to real (external) shocks, $Z_2 = (GROWTH, FINGDP, TO, FO)$;
- ✓ δs for inflation and wage growth $Z_3 = (INF, W)$;
- ✓ ηs for the volatility of nominal effective exchange rate $Z_4 = (HPNEER)$;
- ✓ κs for interaction terms of exchange-rate volatility and the terms-of-trade, money-supply and government-consumption volatility $INT = (NEERVOL * \Delta TOT; NEERVOL * \Delta MS; NEERVOL * \Delta GC)$.

- ✓ Interaction terms are included in order to measure if under real and nominal shocks, respectively, output reacts differently depending on the de-facto rigidity of exchange rate.

We start by checking for unit roots in the series, because this will determine the econometric technique we will use. Presence of unit roots might result in spurious regression, especially if the system co integrates when all variables contain a unit root. Table 2 presents the results from two unit-root tests: Dickey-Fuller test with GLS detrending (Elliott et al., 1996) and Phillips-Perron (1988) test. The first test is a simple modification of the "standard" ADF test, in which the data are detrended so that explanatory variables are "taken out" of the data prior to running the test regression. The second one is a method of controlling for serial correlation when testing for a unit root and hence is more powerful.

Table 2. Uunit-root tests

	Dickey-Fuller GLS		Phillip-Perron	
	Constant	*Constant and trend*	*Constant*	*Constant and trend*
Output volatility				
Standard deviation	-1.465872	-1.927312	-3.641270***	-4.229767***
Hodrick-Prescott	-3.209495***	-2.542284*	-15.93196***	-17.05896***
Real GDP growth	-2.784250***	-2.801045*	-2.793482*	-21.81756***
Bank assets to GDP	0.179218	-2.463689	2.099417	-3.038024
Δ Bank assets to GDP	-0.207146	-9.261956***	-8.977229***	-9.073776***
Trade openness	-0.299929	-2.698388	-5.767014***	-6.387270***
Financial openness	n.a.	n.a.	n.a.	n.a.
Inflation	-167003	-2.806055	-6.725982***	-14.19316***
Wage growth	-2.491863**	-2.981814*	-3.027536**	-2.896382
Volatility of TOT				
Standard deviation	-1.400507	-4.658211***	-4.507487***	-4.568368***
Hodrick-Prescott	-3.085698***	-3.329509**	-3.410794**	-3.362506*
Volatility of money supply				
Standard deviation	-1.846460*	-2.101577	-2.525439	-2.819005
Hodrick-Prescott	-4.249583***	-4.487457***	-6.419451***	-4.429954***
Volatility of gov't consumption				
Standard deviation	-1.475696	-1.834678	-2.659329	-3.055935
Hodrick-Prescott	-3.575594***	-3.623645**	-3.915819***	-3.929221**
Civil unrest	n.a.	n.a.	n.a.	n.a.
NEER	0.410838	-0.710718	-10.22748***	-5.908193***
Standard deviation of NEER	-2.492671**	-3.138714*	-2.468656	-3.273175*
Hodrick-Prescott of NEER	-1.278108	-2.181436*	-4.079782***	-4.543689***

Note: Numbers represent Chi^2 statistics or t-statistics. *, ** and *** indicate that the null of unit root is rejected at 10, 5 and 1% level of significance, respectively.
Regressions for testing unit roots include lags according to an automatic selection to eliminate possible autocorrelation.

We can infer from the table that all included variables except volatilities do not contain a unit root. PP test, in particular, rejects the null of unit root at 1% in the majority of cases. The picture is different for the volatilities. We observe here that if the volatility is calculated based on a rolling standard deviation, than both tests hardly reject the null of a unit root. This is because of the conventional wisdom that this procedure: i) adds persistence to the series, i.e. makes it an autoregressive process (Maddala, 2005); and ii) it tends to generate oscillations – the so-called Yule-Slutsky effect (Bartholomew and Bassett, 1971). On the other hand, the HP procedure, which is based on the difference between the long-run trend of the series and its short-run oscillations, produces fairly stationary data. This is a point which might give different perspective to the results and hence we disregard the estimation based on standard deviations.

Since we have grounds to treat all included variables with the HP volatilities as I(0), we proceed with an instrumental variables estimation. It became very common in macro econometrics that the error distribution cannot be considered independent of the regressors' distribution, i.e. it cannot be said regressors are exogenous. In such cases where the error term and regressor(s) are correlated, least squares estimators render inefficient and inconsistent and advanced procedure for dealing with endogeneity is required. An instrumental variable (IV) is the one which is highly correlated with the regressor (which is assumed to be endogenous), but is not correlated with the error term (Wooldridge, 2007). In a seminal work, Hansen (1982) introduced the generalized method of moments (GMM), whereby information contained into the population moment restrictions is used as instruments. In other words, GMM utilizes the information contained within the lagged values of the included variables to correct the suspected endogeneity of the included regressors. Moreover, GMM makes use of the orthogonality conditions to allow for efficient estimation in the presence of heteroskedasticity of unknown form.

To build the intuition of GMM, we follow Baum et al. (2007), who start with the following equation to be estimated:

$$y_i = X_i\beta + u_i \tag{2}$$

whereby X_i is $n \bullet K$ matrix, n being the number of observations. We partition regressors into endogenous X_1, $E(X_1, u_i) \neq 0$ and exogenous X_2, $E(X_2, u_i) = 0$. The set of instrumental variables is Z; this is the full set of variables that are assumed to be exogenous $E(Z, u_i) = 0$. We partition instruments into excluded instruments Z_1 and the remaining included instruments/exogenous regressors, $Z_2 = X_2$.

The order condition for identification of the equation is $Z \geq X$, implying that there must be at least as many excluded instruments (Z_1) as there are endogenous regressors (X_1), as Z_2 is common to both lists. If $Z = X$, the equation is said to be exactly identified by the order condition; if $Z > X$, the equation is overidentified.

Denoting g_i to be $L \bullet 1$ matrix and considering that Z instruments give Z moment conditions, we can express the GMM estimator in the following form:

$$g_i(\beta) = Z_i^{'} u_i = Z_i^{'}(y_i - X_i\beta) \tag{3}$$

whereby exogeneity means that the following condition is satisfied:

$$E[g_i(\beta)] = 0 \tag{4}$$

For some given estimator $\hat{\beta}$, we can write moment conditions in the following form:

$$\overline{g_i}(\hat{\beta}) = \frac{1}{n}\sum_{i=1}^{n} g_i(\hat{\beta}) = \frac{1}{n}\sum_{i=1}^{n} Z_i^{'}(y_i - X_i\hat{\beta}) = \frac{1}{n} Z^{'}\hat{u} \tag{5}$$

The intuition behind GMM is to choose an estimator for β that brings $\overline{g_i}(\hat{\beta})$ as close to zero as possible and this is the entire procedure that any econometric package does. In addition to this methodological approach, we run a system of equations to explore the interrelations among the different equations and hence to improve the overall efficiency, as shown in the following section.

Yet, we do not have grounds to treat all included variables as endogenous. For instance, terms of trade, trade- and financial openness are variables that are determined by the foreign demand, supply and prices, and hence cannot be regarded as endogenous. Long-run growth is expected to act as a buffer and prevent the output of falling/expanding too much when a shock hits the economy, but no theoretical arguments are on hand for the reverse relationship, nor do empirical-growth models include output volatility as a standard regressor. On the other hand, shocks originating from the monetary and fiscal policy, financial development, inflation and wages might be variables that interact with the output volatility, i.e. the design of the policies that govern these variables might be influenced by the output-volatility developments. The more a country is financially developed, the better buffer is provided for the output volatility when a shock hits the economy; however, increased/lowered output volatility does not directly imply lower/higher financial development, but it could force traders/investors to seek more hedging instruments to prevent risks or credit lines to meet their liquidity needs. Inflation and wage growth, measuring nominal rigidities, could be endogenous, since rational agents could form their expectations based on developments in the real economy. Hence, we treat these variables as endogenous. We use lags of those variables as instruments to correct for possible endogeneity. Results are presented in the next table:

Table 3. Results

Dependent variable: **Volatility of GDP growth**	GMM results	
	Basic	*Augmented*
Volatility of TOT	0.167***	0.024***
Volatility of M2	-0.019***	0.007***
Volatility of government consumption	-0.010***	-0.014***
Civil unrest	0.220**	0.838***
d(Financial development)	0.128***	15.42***
Real GDP growth	0.818***	0.814***
Trade openness	-0.084***	-0.098***
Financial openness	0.586***	-1.274***
Inflation	-0.19***	-0.227***
Wage growth	0.327***	0.306***
Volatility of NEER	0.611***	
Volatility of NEER*Volatility of TOT		-0.098***
Volatility of NEER*Volatility of M2		0.069***
Volatility of NEER*Volatility of government consumption		0.031***
Constant	1.221***	3.061***

R-squared	0.91	0.95
D-W stat	1.99	2.03
J-stat (p-value)	0.231	0.182

Note: *, ** and *** indicate that the null of insignificant coefficient is rejected at 10, 5 and 1% level of significance, respectively.

In the column "basic" we report the regression without interactions, while the column "augmented" reports the regression with interaction. According to the relevant tests, both regressions are well specified and instruments are valid. Regressors explain more than 90% of the variance of the dependent variable. A robustness check is possible at this point between the two regressions, since coefficients do not vary considerably. Robustness checks were performed with excluding some coefficients (like financial development, so that only growth acts as a buffer), and with varying the number of instruments, but coefficients remained stable.

We observe in the "basic" regression that all coefficients are statistically significant, but not all of them have the expected sign. A TOT shock of 1% spurs output volatility by about 0.17%. Monetary and fiscal shocks of 1% do have declining effect on output volatility of 0.02 and 0.01%, respectively, which might be regarded as thoughtful and coordinated, but not powerful policy action. Civil unrest causes output volatility with a magnitude of 0.22%. Surprisingly, the potential buffers - growth and bank assets do have amplifying effect on output volatility; this might be a result of the short-term perspective of government policies, as well as the potential lax of the macro-prudential measures of the supervisory activity. The more economy is economically open, the less are output fluctuations induced, which is highly unsatisfactory, given the dependence of Macedonia on foreign trade. Financial openness, on the other hand, reveals positive effect on growth, given that the higher exposure to capital flows and the fewer capital restrictions make the economy more vulnerable to sudden stops and capital reversals. Inflation and wage growth do have opposite sign, but they might suffer multicollinearity, which is not further examined.

The variable of our academic interest is the volatility of the nominal exchange rate. It is estimated to have a positive effect on output volatility, i.e. the more the exchange rate is flexible, the more output volatility is encouraged. We doubt this is the real picture. At least, it cannot distinguish the opposite effects of the different types of shocks on the output volatility. Hence, the column "augmented" advances this problem, introducing interactions of the three shocks - real, monetary and fiscal, with the volatility of the nominal effective exchange rate. While almost all coefficients remain stable and retain their significance, we observe some notable advances as regard the volatility of the exchange rate. Once the effect of different shocks is partitioned, we observe that a TOT shock still positively affects output volatility, but under a more flexible regime, it starts to affect the output fluctuations negatively, implying the role of a buffer. The aggregated effect is about 0.075% decline of output volatility when a TOT shock of 1% hits under a more flexible alternative of the rate (increased volatility of the rate). Quite the contrary, when nominal shocks (monetary and fiscal) hit the economy, a more rigid alternative of the exchange rate is preferable. The aggregate effects are about 0.075% and 0.017% increase of output volatility when monetary and fiscal shock of about 1% hits, respectively, under a more flexible alternative of the rate (increased volatility of the rate). This is in line with our expectations when real shock hits, flexible rate is more desirable to act as a shock absorber; the opposite, when nominal shock hits, a more rigid form of the exchange rate is preferable. Observing those effects in one basket only smudges this picture.

As a consequence, if real shocks are more dominant than nominal, Macedonia should be thinking of flexibilizing its exchange rate to the extent needed to buffer these shocks. The opposite, if nominal shocks are still principal, the fixed rate should be retained. However, the intensified inclusion of the economy into the international financial market, as well as the need for a faster real convergence of the economy will impose the need authorities to think of gradual relaxation of the exchange-rate policy to support the real economy.

5. Conclusions

The objective of the study was to empirically explore the relationship between exchange-rate rigidity and output volatility for Macedonia, building on the flaws of the existing, though scarce literature on the topic. Specifically, it carefully constructed the output volatility regression; considered the measure of output volatility; and accounted for the endogeneity bias doubted to be present in the respective literature. We constructed an eclectic model of the output volatility whereby output volatility is regressed on: terms-of-trade (TOT) volatility, volatility of money supply, volatility of government spending (all three representing shocks); real GDP growth and bank assets-to-GDP ratio (both representing buffers); civil unrest (to represent a political shock); inflation and wage growth (nominal rigidities); and trade and financial openness (exposure to shocks). Finally, we include the volatility of the nominal effective exchange rate (NEER), to capture the rigidity of the exchange rate in Macedonia, but in an augmented framework we use interactions of this variable with the TOT, money and government volatilities, to distinguish nominal from real shocks under different exchange rate rigidity. We utilize a Hodrick-Prescott definition of volatility, to avoid persistent series which are obtained by using rolling standard deviations.

The empirical investigation covered the period 1998:Q1 - 2009:Q2 and used a GMM estimator. We found that, in general, a TOT shock opts to increase output volatility, but under a more flexible regime, it starts to affect the output fluctuations negatively, implying a role of a buffer. The aggregated effect is about 0.075% decline of output volatility when a TOT shock of 1% hits under a more flexible alternative of the rate. Quite the contrary, when nominal shocks (monetary and/or fiscal) hit the economy, a more rigid alternative of the exchange rate is preferable. The aggregate effects are about 0.075% and 0.017% increase of output volatility when monetary and fiscal shock of about 1% hits, respectively, under a more flexible alternative of the rate. This is in line with our expectations that when real shock hits, flexible rate is more desirable to act as a shock absorber; the opposite, when nominal shock hits, a more rigid form of the exchange rate is preferable. Observing those effects in one basket only obscures this picture. As a consequence, if real shocks are more dominant than nominal, Macedonia should be thinking of flexibilizing its exchange rate to the extent needed to buffer these shocks. And, the contrary, if nominal shocks are still principal, the fixed rate should be retained.

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